

Many types of indoor pollution problems are found in homes. The most effective approach to solving these problems is usually to remove or reduce the sources of indoor pollution. Ventilation also helps remove indoor air pollutants, but not as effectively as source reduction. Air cleaning devices (air filters and air cleaners) can also be helpful when used along with source reduction and ventilation.

The best solution to the air pollution within your home will depend, of course, on your particular problem, the effect it is having on your family's health, and your family's budget. The information below will help you decide if an air cleaning device would be useful as a part of your solution to indoor pollution, and if so, what type might best meet your needs. Many of the principles discussed here also apply to offices, schools, and vehicles.

How Effective Are Air Cleaning Devices ?

Air cleaning devices alone cannot adequately remove all indoor pollutants from homes. This is especially true when the sources emit a large amount of pollution, or when the pollutants settle rapidly on surfaces. Most air cleaning devices will remove some of the particles from the indoor air but will not effectively remove certain types of pollutants, such as carbon monoxide, radon, odors, lead dust, and allergens from mold, dust mites, roaches, and pets.

Air cleaning devices usually come as portable, stand-alone appliances, or as filters or cleaners in a central air system. Portable units can usually help clean the air in a single room, while central air units may improve the air throughout the house.

The health benefits of air cleaning devices are not clear, based on the very limited scientific evidence that is currently available. However, it is clear that you should never use an air cleaner that deliberately produces ozone (ozone generators). Ozone generators cause indoor pollution and do not clean the air, as discussed later in this document.

How Do I Improve My Existing Air Filters ?

Central forced air systems in homes usually have a rectangular, one-inch thick fiberglass filter that slides underneath the furnace fan, or into a wall or ceiling register where the air returns to the furnace. These filters remove less than 10% of the particles, ten microns or less in size, that reach the filter. They are disposable and typically cost \$2 to \$3.

Often, merely upgrading this filter to a medium- or high-efficiency filter will help improve the air quality in your home. Medium-efficiency filters are typically pleated, woven material and are rated at 20-50% efficiency for removing particles of 0.3 to 10 microns (a micron is one millionth of a meter). They cost about \$5 to \$20, and both disposable and washable models are available. Some medium-efficiency filters use static electricity created by air flow, but their effectiveness may decline as the static charge decreases over time.

High-efficiency filters (sometimes mistakenly called "HEPA" filters) are rated at 60-95% efficiency.

They cost about \$20-\$130, depending on whether they are disposable or washable. True HEPA (high efficiency particle arrestance) filters are 99.97% efficient, require very powerful fans, and are rarely used in central forced air systems of homes.

Proper installation, operation, and maintenance are critical for effective operation of air filters:

- To maintain filter efficiency, make sure that the filter fits tightly in its seat to prevent air from bypassing the filter.
- Check the filter for dust and debris buildup at least every month during heavy use. Replace or clean the filter as necessary, based on the manufacturer's recommendations.
- To accurately show when a high-efficiency filter needs changing, you may want to have an inexpensive pressure gauge installed; the filter manufacturers recommend maximum pressure drops for each filter model. Some filters or air cleaners come with a sensor that indicates when filter replacement is necessary.
- To prolong the useful life of a high-efficiency filter, you may want to install a low-efficiency pre-filter upstream in order to prevent rapid overloading of the filter.

What Type Of Air Cleaning Device Do I Need ?

Even if you have taken actions to remove pollutant sources in and near your home, provided ventilation, and upgraded your central air filters, you may still have a problem with excess dust or odors. If so, you may benefit from an air cleaner. The information below will help you determine what type and size of air cleaner you need, and how to use it properly.

Air cleaners are available in different configurations: portable units for single rooms, and larger central air cleaners for large rooms or the whole house. Smaller portable units typically cost between \$50 and \$150, while larger or more efficient portable models may cost \$300 or more. Central air cleaners can cost on the order of \$1000 to \$3000, depending on the size and efficiency of the device.

Most air cleaners remove particles, a few remove gases (and odors), and some do both. If you feel you have pollutants other than particles and dust that require removal, consult a reference book such as the U.S. Environmental Protection Agency's *Introduction to Indoor Air Quality, A Reference Manual*, or contact an experienced indoor air quality consultant. If you spend much time outdoors when levels of dust or allergens are high, you should consider wearing a properly fitting dust mask designed for particles; contact the mask manufacturer for fitting instructions.

PARTICLE REMOVAL. Some types of air cleaners can effectively remove particles such as dust and allergens from the air: mechanical or physical-barrier air cleaners, and electronic air cleaners.

Mechanical air cleaners. These devices draw air through a fibrous or metal filter with different sized pores that trap particles. These devices should use high- or medium-efficiency filters (see above). The filter will need to be sealed tightly in its seat, and replaced regularly, although some units have filters that can be cleaned and re-used. These filters may be flat, round, or pleated.

Electronic air cleaners. There are three types of electronic air cleaners: electrostatic precipitators (ESPs), ionizers, and mechanical-electronic hybrids. ESPs use a small electrical charge to collect particles from air pulled through the device. Ionizers, or negative ion generators, cause particles to stick to materials near the ionizer (such as the carpet and walls). Also available are hybrid air cleaners that have both mechanical and electronic devices for pollutant removal.

Both ESPs and ionizers produce ozone as a by-product. To minimize ozone emissions, these

devices need to be cleaned and maintained regularly and operated only according to the manufacturer's instructions. High levels of ozone may create unhealthful air quality and a pungent odor. Ozone generators are discussed later in this document.

GAS REMOVAL. Residential air cleaning devices that remove gases and odors are relatively costly, both to purchase and maintain. Gaseous pollutants are typically trapped or destroyed as the air is drawn through materials such as activated charcoal or alumina coated with potassium permanganate. However, the filter material can become quickly overloaded and may need to be replaced often.

These filters (usually charcoal) are offered as an option with some residential particle air cleaners. If you have very sensitive individuals in your home or odors that are difficult to remove, especially in just one area of the home, you may want to consider this option. However, in most homes, a particle filter is all that is needed.

PORTABLE AIR CLEANERS. Portable air cleaners are practical for existing homes where addition of a central air cleaner is too costly. Proper size, installation, and maintenance are critical for portable air cleaners to be effective.

- See the Appendix for examples of how to determine size requirements.
- Install the unit(s) in the room(s) where you spend most of your time or have the worst symptoms.
- Locate the air cleaner as close as possible to any identifiable pollution sources.
- Locate the unit away from doors, windows, and foot traffic, but not close to walls or corners, so that air may easily reach the air cleaner.

CENTRAL AIR CLEANERS. For new homes or major remodels, "whole-house" or "fresh-air" ventilation systems can be installed separately from the central heating and cooling system. These systems typically use an air filter, small-diameter ducts, a quiet energy-efficient fan, and a heat-recovery ventilator (optional). Installed costs are about \$1200 or more, depending on the system size and the type of air cleaning device. Fresh-air ventilation systems are recommended in new, tightly built energy-efficient houses, and for situations where the outdoor air is the major source of indoor pollution.

Central air cleaners can also be added to conventional forced air systems in new or existing homes. However, a more powerful fan may be required to move sufficient air through some types of air cleaners. In addition, energy costs for constant fan operation can be significant. Alternatively, some manufacturers produce forced air systems that have a two-speed or variable speed fan, so that the system can operate at a lower fan speed when a lower rate of air cleaning or fresh air ventilation is needed. Access for maintenance also can be problematic. In addition, these systems do not normally come with an outdoor air supply, so further modifications may be needed.

To design and install any central system air cleaner, contact a company or contractor that is well experienced in designing and installing central filtration systems. Request a system that is low-leakage, easy to maintain, and energy efficient.

What Size Air Cleaner Should I Get ?

The effectiveness of some portable air cleaners in removing particles is usually rated in terms of pollutant removal efficiency, or Clean Air Delivery Rate (CADR), measured in cubic feet per minute (cfm). The CADR equals the airflow (cfm) multiplied by the efficiency of particle removal; a larger CADR is better. The CADR ratings are given separately for the removal of dust, pollen, and environmental tobacco smoke.

For air filters in forced air systems, it is most appropriate to use test ratings that are based on particle sizes smaller than ten microns. This particle size range is of the greatest health concern. Test standards for particle removal by air cleaning devices have been developed by trade and engineering groups, but standards for gas removal have not been developed. National groups that set consensus standards may recommend test standards for gas removal within the next few years.

Larger air cleaners usually produce more noise and use more energy than smaller units do. For these reasons, you should avoid getting an air cleaner that is oversized for the room(s) you are cleaning.

PORTABLE AIR CLEANER. Select an air cleaner that can replace the room air at least two or three times per hour, enough to rapidly reduce indoor pollutant levels. Most portable units will state on the package the unit's air flow rate (in cfm), the size room it cleans, and perhaps its particle removal efficiency and its CADR. The appropriate size for a portable air cleaner can then be calculated following the formula and example shown in the Appendix.

CENTRAL SYSTEM AIR CLEANER. Size the air cleaner to handle at least 0.5 air changes per hour. This is the air exchange rate (AER) necessary to continuously ventilate a house lacking a significant indoor pollutant source, under most conditions. To avoid major air flow (and energy) loss, have your system's ductwork pressure tested for leakage and then sealed and insulated as necessary.

Where Can I Buy Air Filters And Air Cleaners ?

Most department, home supply, hardware, and discount stores now offer several models of portable air cleaners and central system air filters of varying efficiencies. Allergy supply stores, drug stores, and medical supply businesses also typically offer several models. Air cleaners and replacement filters can be ordered on the Internet. Central air cleaning systems should be designed and installed by an experienced, licensed mechanical contractor or heating and ventilating contractor.

What Types Of Air Cleaners Are Not Effective ?

OZONE GENERATORS. The California Department of Health Services advises the public not to use so-called "air purifiers" that are specifically designed to generate ozone indoors. These ozone generators are sometimes marketed as emitting "trivalent" oxygen, "activated" oxygen, "allotropic" oxygen, "saturated" oxygen, "superoxygen," or "mountain-fresh air." These devices may also be combined with a negative ion generator. However, these devices are actually emitting ozone.

Ozone is a harmful air pollutant that is the main ingredient of ground-level smog. Breathing ozone can be harmful, especially for children, the elderly, and people with asthma, emphysema, bronchitis, or other respiratory diseases. Ozone also irritates the eyes, nose, and throat. Long-term exposure to ozone may permanently reduce a person's breathing ability.

Ozone at safe levels does not clean the air. Independent studies by the U.S. Environmental Protection Agency, the Consumers Union, and others have shown that these devices do not effectively destroy microbes, remove odor sources, or reduce indoor pollutants enough to provide any health benefits. Ozone masks the odor of other indoor pollutants by deadening the sense of smell. It also reacts with certain indoor pollutants to produce toxic byproducts, such as formaldehyde. Ozone is used effectively in water to destroy microbes, but ozone in air must reach extremely hazardous levels (50-100 times the outdoor air quality standards) to effectively kill microbes.

The Federal Trade Commission (FTC) has successfully sued a major manufacturer of ozone generators for making unsupported health claims. These claims involve the products purported

ability to remove indoor air pollutants, to prevent or relieve allergies, asthma and other health conditions, or to create harmful by-products such as formaldehyde. Health Canada has listed the ozone generator models that should not be used in homes or on the person (see References at the end of this document).

DUCTLESS RANGE HOODS. Air filters in kitchen range hoods that exhaust air into the house (ductless hoods) trap much of the grease from cooking. However, they do not effectively remove the air pollutants and moisture produced by cooking or by cooking appliances that burn natural or propane gas. Only ducted hoods that exhaust to the outdoors should be used. For additional information on range hoods and dust control, see ARB's Indoor Air Quality Guideline No. 2, *Combustion Pollutants in Your Home* (see References below).

DESKTOP AIR CLEANERS. Small, desktop air cleaners have been shown to have very little effect on indoor pollutants.

HOUSEPLANTS. Houseplants do not effectively remove indoor air pollutants. One researcher has reported that certain houseplants can remove significant amounts of indoor air pollutants. However, subsequent reviews and a study in office buildings and portable office buildings indicated that houseplants have very little, if any, effect on indoor pollutant levels. Small effects

might occur, but only with an unreasonably large number of houseplants present, which could easily cause other indoor pollution problems such as excess moisture.

How Can I Shield My Home Interior From Outdoor Air Pollution?

Outdoor pollution from such sources as fires, wind-blown dust, pollen, motor vehicles, and industrial and commercial activities can contribute to indoor air pollution. Reducing the penetration of unfiltered air while minimizing indoor pollution sources can help shield your home interior during outdoor pollution episodes:

- Closing doors and windows and sealing up air leaks in a home's exterior shell and its central air ductwork can help reduce the rate of outdoor pollution entering your home.
- Care should be taken to minimize all sources of indoor air pollutants, including pollutants entering from attached garages.
- Using an air cleaner may also help remove some of the pollutants, but is not likely to control strong odors.
- For short-term episodes of outdoor pollution, turning off mechanical ventilation equipment such as forced air systems and exhaust fans will reduce the penetration of outdoor pollutants into the home. Interior fans can be used for temporary cooling.
- For long-term or recurrent episodes of outdoor air pollution, permanent installation of a mechanical ventilation system that provides filtered outdoor air should be considered (see discussion above on Central Air Cleaners).

Where Can I Obtain More Information ?

The references listed below provide extensive, useful information on residential air cleaning devices. If you have questions or would like to receive a copy of ARB's Indoor Air Quality Guidelines and Supplements, please contact us at:

Indoor Air Quality and Personal Exposure Assessment Program
Research Division, California Air Resources Board
P.O. Box 2815, Sacramento, CA 95812
Phone: 916-322-8282, Fax: 916-322-4357

This document is also available on the Internet at the following URL:

<http://www.arb.ca.gov/research/indoor/indoor.htm>.

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APPENDIX

Estimating the Size of Air Cleaner Needed

If necessary, you can calculate an air cleaner's air flow rate needed for a given space in your home. Use the following formula, as shown in the examples below for a 50% efficient air cleaner and Air Exchange Rates (AER, the amount of indoor air replaced by outdoor air each hour). The AERs used below are typical values used only as examples; the appropriate AER will depend on the rate of outdoor air supply to the building, the size of the indoor pollutant sources, and the speed of pollutant removal that is desired.

$$\text{Air Flow Rate needed (cfm)} = A \times B \times C \times D$$

$$\div E$$

EXAMPLES FOR SIZING AIR CLEANERS

A	B	C	D	E	Air Flow Rate
Your Floor Area of room to be cleaned (square ft.)	Ceiling Height of room (ft.)	Air Exchange Rate (AER) desired (per hour)	Convert hours to minutes (constant)	Efficiency Factor of the air cleaner (see product specs.)	$= A \times B \times C \times D \div E$ (cfm; ft ³ /minute)
200 (room)	8	3	0.017	0.50	163
2000 (house)	8	0.5	0.017	0.50	272

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